SULIT

POLITEKNIK
Jabatan Pengajian Politeknik

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2013

EJ301 : BASIC CONTROL SYSTEM

TARIKH : 29 OKTOBER 2013
TEMPOH : 2 JAM (11.15 AM – 1.15 PM)

Kertas ini mengandungi **TUJUH BELAS (17)** halaman bercetak.
Bahagian A: Objektif (20soalan)
Bahagian B: Struktur (10 soalan)
Bahagian C: Esei (2 soalan)
Dokumen sokongan yang disertakan :Jadual Laplace, Jadual Pengecilan Gambarajah Blok

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A : 20 MARKS
BAHAGIAN A : 20 MARKAH

INSTRUCTION:
This section consists of **TWENTY (20)** objective questions. Mark your answers in the OMR form provided.

ARAHAN :
*Bahagian ini mengandungi **DUA PULUH (20)** soalan objektif. Tandakan jawapan anda di dalam borang OMR yang disediakan.*

CLO1
C1

1. The final control element is positioned by a signal from the _____.

Kedudukan elemen kawalan terakhir ialah menerima isyarat dari _____.

A. Sensor / *pengesan*
B. Comparator / *pembanding*
C. Controller / *pengawal*
D. Process / *proses*

CLO1
C1

2. Which of the following application is the example of open loop control system.

Yang manakah penggunaan berikut merupakan contoh bagi sistem kawalan gelung terbuka.

A. Toaster system. / *Sistem pembakar roti*
B. Electric switch. / *Suis elektrik*
C. Sprinkler used to water a lawn. / *Pemercik air yang digunakan untuk menyiram*
D. All the above. / *Semua di atas*

CLO1
C2

3. Closed loop control systems should have which of the following properties:

Sistem kawalan gelung tutup mempunyai ciri-ciri berikut :

A. desirable responses to commands
tindak balas yang wajar kepada arahan

B. good regulation against disturbance
pengaturan yang baik terhadap gangguan

C. low sensitivity to changes in the plant parameters
sensitiviti yang rendah kepada perubahan di dalam parameter loji

D. all of the above
semua di atas

CLO1
C1

4. The condition of the controlled variable is referred as _____.

*Keadaan pembolehubah terkawal adalah merujuk kepada*_____.

A. reference /*rujukan*
B. measured variable / *pembolehubah yang diukur*
C. primary status / *status utama*
D. manufacturing process / *proses pembuatan*

CLO1
C1

5. Based on the statement below, name the related type of control system.

Berdasarkan kenyataan di bawah, namakan jenis sistem kawalan yang berkaitan.

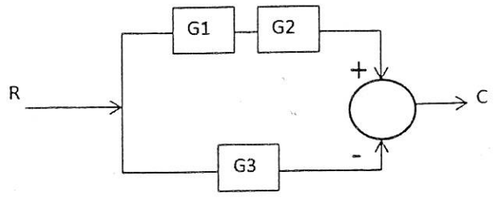
- Output quantity has no effect on the input quantity
  Kuantiti keluaran tidak memberi kesan ke atas kuantiti masukan
- No facility to correct automatically the error generated in the output
  Tiada kemudahan untuk membetulkan kesilapan yang dijana pada keluaran
- The output can be varied by varying the input. But due to the external disturbance system output may change
  Keluaran boleh diubah oleh pelbagai masukan. Tetapi disebabkan gangguan luaran sistem keluaran boleh berubah

A. Open loop control system / *sistem kawalan gelung buka*
B. Closed loop control system / *sistem kawalan gelung tutup*
C. Multivariable control system / *sistem kawalan pelbagai pembolehubah*
D. Combinational Control system / *sistem kawalan gabungan*

CLO1
C3

6. Simplify the block diagram below.

Permudahkan gambarajah blok di bawah.



A. C/R = G1 + G2 + G3
B. C/R = G1G2 – G3
C. C/R = G1 + G2 - G3
D. C/R = G1G2 + G3

CLO1
C3

7. Given $F(s) = 5 /3s^2$. Calculate f(t).

Diberi $F(s) = 5 / 3s^2$. *Kirakan f(t).*

A. $f(t) = 5t$
B. $f(t) = 5t^3$
C. $f(t) = 5t^2 /3$
D. $f(t) = 5t/3$

CLO1
C3

8. Given $f(t) = -5e^{-3t}$, Calculate F(s).

Diberi $f(t) = -5e^{-3t}$. *Kirakan F(s).*

A. $F(s) = -5/(s - 3)$
B. $F(s) = -5s/3$
C. $F(s) = -5/(s + 3)$
D. $F(s) = -5/3s$

CLO1
C4

9.

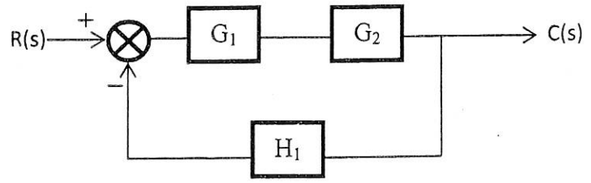
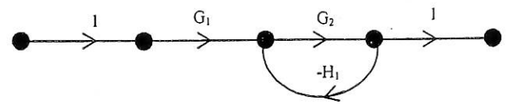


Figure A9 / *Rajah A9*

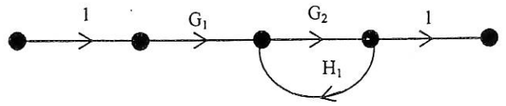
Which signal flow graph is correct based on block diagram in Figure A9.

Graf aliran isyarat manakah yang benar berdasarkan gambarajah blok pada Rajah A9.

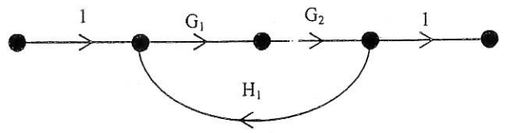
A.



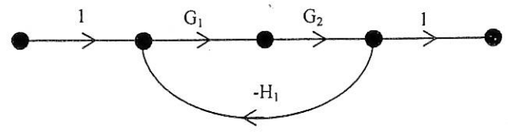
B.



C.



D.



CLO1
C4

10. Laplace Transform formula can be defined as _____

Formula Transformasi Laplace didefinisikan sebagai _____

A. $F(s) = \int_0^\infty f(t).e^{-st}dt$

B. $F(s) = \int_\infty^0 f(t).e^{-st}dt$

C. $F(s) = \int_0^\infty f(t).e^{st}dt$

D. $F(s) = \int_\infty^0 f(t).e^{st}dt$

For Questions 11 and 12, please refer to Figure A11.

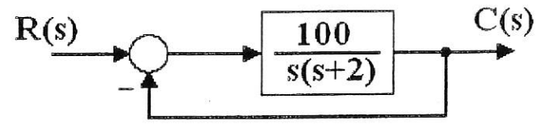


Figure A11/ *Rajah A11*

CLO1
C3

11. For the system shown on Figure A11, calculate the percentage of maximum overshoot (% Mp) when it is subjected by unit step input.

Bagi sistem yang ditunjukkan pada Rajah A11, kirakan peratus lajakan maksimum (% Mp) apabila ia diberi dengan masukan langkah unit.

A. 2.00%
B. 3.21%
C. 5.66%
D. 9.47%

CLO1
C3

12. Based on Figure A11, calculate the value of settling time (Ts) when it is subjected by unit step input.

Berdasarkan Rajah A11, kirakan nilai masa pengenapan (Ts) apabila diberi dengan masukan langkah unit.

A. 0.36 sec
B. 0.67 sec
C. 0.85 sec
D. 0.94 sec

CLO1
C3

13. For good time response, the system demands_____

*Bagi sambutan masa baik, sistem memerlukan*_____

A. Less settling time / *masa pengenapan rendah*
B. Less overshoot / *kurang terlajak*
C. Largest steady state error / *ralat keadaan mantap besar*
D. Less rise time / *masa menaik rendah*

CLO1
C3

14 Calculate the steady state error of a control system with a unit step input when given the error constant, Kp = ∞.

Kira ralat keadaan mantap sistem kawalan dengan masukan langkah unit apabila diberi pemalar ralat, kp = ∞.

A. 0
B. 0.5
C. 1
D. ∞

CLO1
C4

15. Based on the statement below, classify the related respond type of control system.

Berdasarkan kenyataan di bawah, kelaskan jenis respon sistem kawalan yang berkaitan.

- Systems which have damping ratio lying between zero and unity.

  Sistem yang mempunyai nisbah redaman di antara sifar dan satu.

A. underdamped system / *sistem redaman kurang*
B. criticaly damped system / *sistem redaman genting*
C. overdamped system / *sistem redaman lebih*
D. unity system / *sistem uniti*

CLO1
C4

16. Consider the following statement:

Pertimbangkan kenyataan berikut:

i. One of the most common and simplest mode of controller.
Salah satu mod pengawal yang paling biasa dan paling mudah.

ii. This controller also called ON – OFF controller mode.
Pengawal ini juga dipanggil BUKA – TUTUP mod pengawal.

iii. Mathematically can be expressed as,
Secara matematik ianya boleh dinyatakan sebagai,

P = 0% ep<0
= 100% ep>0

Select the appropriate controller for the above statements.

Pilih pengawal yang sesuai untuk kenyataan di atas.

A. Proportional controller mode / *mod pengawal berkadaran*
B. Derivative controller mode / *mod pengawal pembezaan*
C. Multiposition mode / *mod berbilang kedudukan*
D. Two position mode / *mod dua kedudukan*

CLO1
C4

17. Based on Figure A17, select the controller that explains the block diagram.

Berdasarkan kepada Rajah A17, pilih pengawal yang menjelaskan gambarajah blok tersebut.

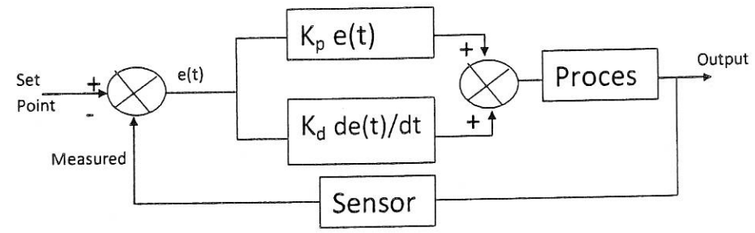


Figure A17/ *Rajah A17*

A. Proportional (P) / *Berkadaran (P)*
B. Integral (I) / *Kamiran (I)*
C. Proportional + Derivative (PD) / *Berkadaran + Perbezaan (PD)*
D. Proportional + Integral (PI) / *Berkadaran + Kamiran (PI)*

CLO1
C4

18. Mathematically, the proportional control mode is expressed as:

Secara matematiknya, pengawal mod jenis berkadaran dinyatakan sebagai:

$$P(t) = K_p e(t) + P_o$$

Define K_p.

Berikan maksud K_p.

A. Proportional gain constant / *Pemalar gandaan berkadaran*
B. Proportional control mode / *Mod kawalan berkadaran*
C. Proportional error detector / *Pengesan raiat berkadaran*
D. Proportional band output / *Keluaran ruang berkadaran*

CLO1
C4

19. Identify which type of controller that can increase the speed of the response in order to reach the desired fastest set point while eliminating offset.

Kenal pasti jenis pengawal manakah boleh meningkatkan kelajuan tindak balas untuk mencapai titik set yang diingini paling cepat sambil menghapuskan ralat.

A. On-Off controller / *Kawalan buka tutup*
B. Integral controller / *Kawalan kamilan*
C. Derivative controller / *Kawalan pembezaan*
D. Proportional-Integral controller / *Kawalan perkadaran-kamilan*

CLO1
C4

20.
- PI mode control / *mod kawalan PI*
- PD mode control / *mod kawalan PD*
- PID mode control / *mod kawalan PID*

Based on the statement above, what does this controller represent.

Berdasarkan kenyataan di atas, pengawal manakah yang sesuai.

A. Single control mode / *mod kawalan tunggal*
B. Variable control mode / *mod kawalan boleh ubah*
C. Advance control mode / *mod kawalan mara*
D. Composite control mode / *mod kawalan gabungan*

SECTION B : 30 MARKS

BAHAGIAN B : 30 MARKAH

INSTRUCTION:

This section consists of **TEN (10)** structured questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **SEPULUH (10)** soalan berstruktur. Jawab **SEMUA** soalan.*

CLO1
C1

QUESTION 1

Label the blank block diagram of automatic toaster in Figure B1 below.

SOALAN 1

Labelkan ruang kosong pada rajah blok bagi pembakar roti automatik di dalam Rajah B1 di bawah.

[3 marks]

[*3 markah*]

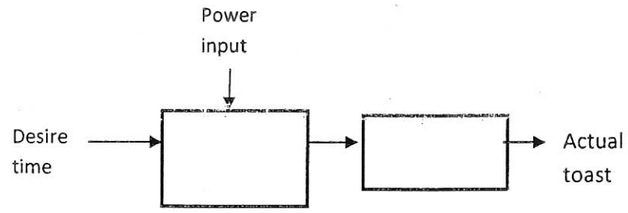


Figure B1 / *Rajah B1*

CLO1
C1

QUESTION 2

Draw the block diagram of closed loop control system.

SOALAN 2

Lukiskan gambarajah blok bagi sistem kawalan gelung tertutup.

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 3

Calculate the Laplace transform of $f(t)= e^{-at}$

SOALAN 3

Kirakan Jelmaan Laplace bagi $f(t)=e^{-at}$.

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 4

Referring to the block diagram in Figure B4, determine the transfer function of the system.

SOALAN 4

Merujuk kepada Rajah B4, tentukan rangkap pindah untuk sistem ini.

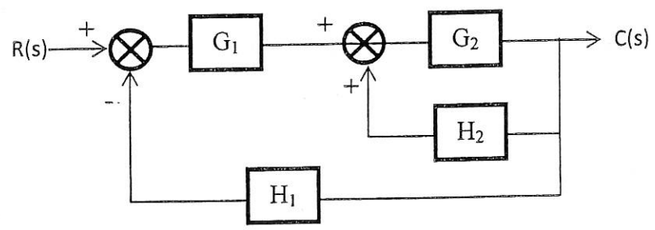


Figure B4 / *Rajah B4*

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 5

Sketch transient response specifications for rise time and delay time.

SOALAN 5

Lukiskan spesifikasi sambutan fana bagi masa menaik dan masa lengah.

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 6

Calculate the type of damping ratio in the following system.

$$\frac{C(s)}{R(s)} = \frac{8}{s^2+3s+8}$$

SOALAN 6

Kirakan jenis nisbah redaman bagi sistem berikut.

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 7

Illustrate **THREE (3)** standard input test signals used in control system.

SOALAN 7

Gambarkan ***TIGA (3)*** *isyarat masukan ujian piawai yang digunakan dalam sistem kawalan.*

[3 marks]

[*3 markah*]

CLO1
C2

QUESTION 8

Explain briefly the mathematical expression of PID controller mode.

SOALAN 8

Terangkan secara ringkas persamaan matematik bagi mod pengawal jenis PID

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 9

The range of measure variable for a certain control system is 4mV to 14mV and a set point of 8mV. Calculate the error in percentage when the measured variable is 7.5mV.

SOALAN 9

Julat pembolehubah ukuran untuk sistem kawalan tertentu adalah 4mV hingga 14mV dan titik set ialah 8mV. Dapatkan ralat di dalam peratus apabila pembolehubah yang diukur ialah 7.5mV.

[3 marks]

[*3 markah*]

CLO1
C3

QUESTION 10

By referring to Figure B10, calculate the output value of PD controller when K_p=6 and K_D=0.4 with p(0)=25%.

SOALAN 10

Berdasarkan kepada Rajah B10, kirakan nilai keluaran bagi pengawal jenis PD apabila K_p=6 d an K_D=0.4 dengan p(0)=25%.

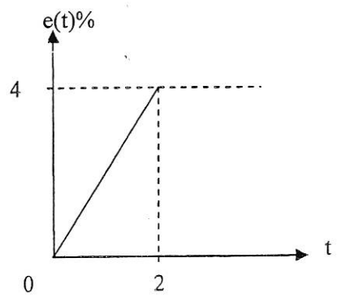


Figure B10 / *Rajah B10*

[3 marks]

[*3 markah*]

SECTION C : 50 MARKS

BAHAGIAN C : 50 MARKAH

INSTRUCTION:

This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C3

(a) Construct the inverse Laplace Transform of the following function.

Dapatkan songsangan Jelmaan Laplace bagi fungsi berikut.

$$F(s)=\frac{s+3}{(s+1)(s+2)^2}$$

[10 marks]

[10 *markah*]

CLO1
C3

(b) Determine the transfer function of the block diagram in Figure C1a by using block diagram reduction method.

Tentukan rangkap pindah bagi rajah blok di Rajah C1a menggunakan kaedah pengecilan gambarajah blok.

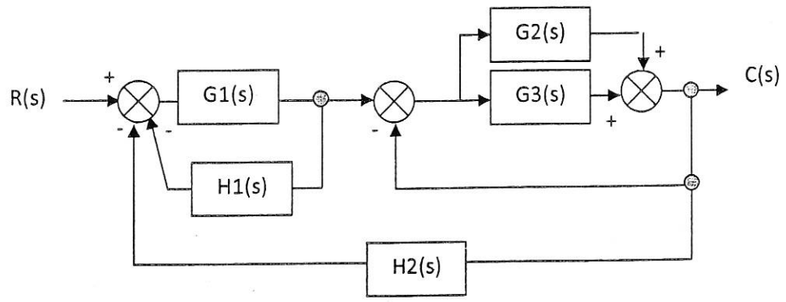


Figure C1a / *Rajah C1a*

[12 marks]
[12 *markah*]

CLO1
C3

(c) Based on Figure C1a, draw the Signal Flow Graph.

Berdasarkan Rajah C1a, lukiskan Graf Aliran Isyarat.

[3 marks]
[3 *markah*]

QUESTION 2
SOALAN 2

CLO1
C4

By referring to the second order transfer function system below:

Dengan merujuk kepada rangkap pindah sistem tertib kedua di bawah:

$$\frac{C(s)}{R(s)} = \frac{52}{S^2 + 5S + 52}$$

Calculate:

Kira:

i. Natural frequency, ω_n / *Frekuensi semulajadi, ω_n*

[3 marks]
[3 markah]

ii. Damping ratio, ζ / *Nisbah redaman, ζ*

[3 marks]
[3 markah]

iii. Damped frequency ,ω_d / *Frekuensi teredam, ω_d*

[3 marks]
[3 markah]

iv. Peak time, Tp / *Masa puncak, Tp*

[3 marks]
[3 markah]

v. Settling time, Ts / *Masa pengenapan, Ts*

[3 marks]
[3 markah]

vi. Rise time, Tr / *Masa naik, Tr*

[5 marks]

[5 markah]

vii. % Maximum overshoot, Mp / *% Lajakan maksima, Mp*

[5 marks]

[5 markah]

SOALAN TAMAT